Return-to-duty rates among US military combat-related amputees in the global war on terror: Job description matters

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BACKGROUND: The purpose of this study was to identify the differences seen between military occupation services (MOS) in terms of amputation patterns, subsequent disabling conditions, and their ability to return to duty.

METHODS: A retrospective study of major extremity amputations sustained by US service members between October 1, 2001, and July 30, 2011, was performed. Data obtained from the amputation database, Joint Trauma Theater Database, and the Physical Evaluation Board Liaison Office included demographics, amputation location(s), Injury Severity Scores (ISSs), disabling conditions, disability ratings, and disposition status.

RESULTS: There were 1,221 major extremity amputees identified during the specified time frame, of which 899 had data regarding disabling conditions, ratings, and disposition. All service branches were represented. Personnel from the US Army (USA) Infantry were significantly ($p < 0.0001$) more likely to sustain an amputation than other MOS. The USA Infantry, the US Marine Corps Infantry and the USA Armor represented the top three specialties and accounted for more than 57% of all amputees. Approximately 89% of all service members did not return to duty, and the mean combined for all amputees was 76. USA Special Forces (USA SF) operators were significantly more likely to return to duty (p 0.0022) and be found fit for duty (p 0.0015) than all other MOS despite having a mean ISS (20) that was no different from those of other service members. No USA SF personnel were found to have posttraumatic stress disorder as a disabling condition.

CONCLUSION: All amputees, regardless of MOS, are not likely to return to active duty and especially unlikely to be found fit for duty, except for members of the USA SF. The reason(s) for the increased return to duty for USA SF personnel remains unknown but a lack of posttraumatic stress disorder may be a contributing factor. (*J Trauma Acute Care Surg*. 2013;75: 279 286. Copyright © 2013 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Epidemiologic study, level IV.

KEY WORDS: Extremity amputation; military specialty; return to duty; disability; Iraq, Afghanistan.

As the US Military's involvement in current conflicts in Southwest Asia deescalates, it is important to assess which service members have sustained amputations in combat and the impact these amputations have had on their lives. Previous articles have characterized extremity injuries and amputations during recent conflicts, but there has been scarce information pertaining to the amputee's background.[1–4] Recent civilian literature has provided insight into the characteristics and patient-related factors associated with high-energy extremity injuries, but few data exist on military amputees.[5–8] Furthermore, studies have demonstrated a statistically significant association between patient characteristics and the outcome of their injuries.[5–8] Military occupational specialties (MOS) vary greatly relative to the environment in which members of those occupations must operate and the risk their operations entail. Insight into the MOS that sustain the greatest number of amputations or those that are able to return those amputees to duty at higher rates than other MOS may lead to advances in combat-wounded care. Lastly, while the perception exists that military populations have a high level of function following combat-related amputation, the purpose of this study was to quantify return-to-duty rates among MOS to clarify the ability of this amputee population to return to their occupational requirements.

The data available from 2001 to 2011 derived from the Iraq and Afghanistan conflicts include 1,631 amputations and 1,221 amputees; 93% of these injuries result from explosive events.[4] Using this cohort, we can further our understanding of amputations by examining the service members' MOS and outcome. The purposes of this study were to identify which service members, based on their MOS, sustain the majority of amputations and to describe the disabling conditions and outcomes of the amputees within each MOS.

PATIENTS AND METHODS

This study was conducted under a protocol reviewed and approved by our institutional review board. The patient cohort for this study was adopted from a previously published cohort of major extremity amputations sustained between October 1, 2001,

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From the Brooke Army Medical Center (J.G.B., C.A.K.); and US Army Institute of Surgical Research (J.C.W.), Fort Sam Houston, San Antonio, Texas.
The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Department of the Army, Department of Defense, or the US government. This work was prepared as part of their official duties and, as such, there is no copyright to be transferred.
This study commenced after being approved by the US Army Institute of Surgical Research Institutional Review Board.
This study was conducted under a protocol reviewed and approved by the US Army Medical Research and Materiel Command Institutional Review Board and in accordance with the approved protocol.
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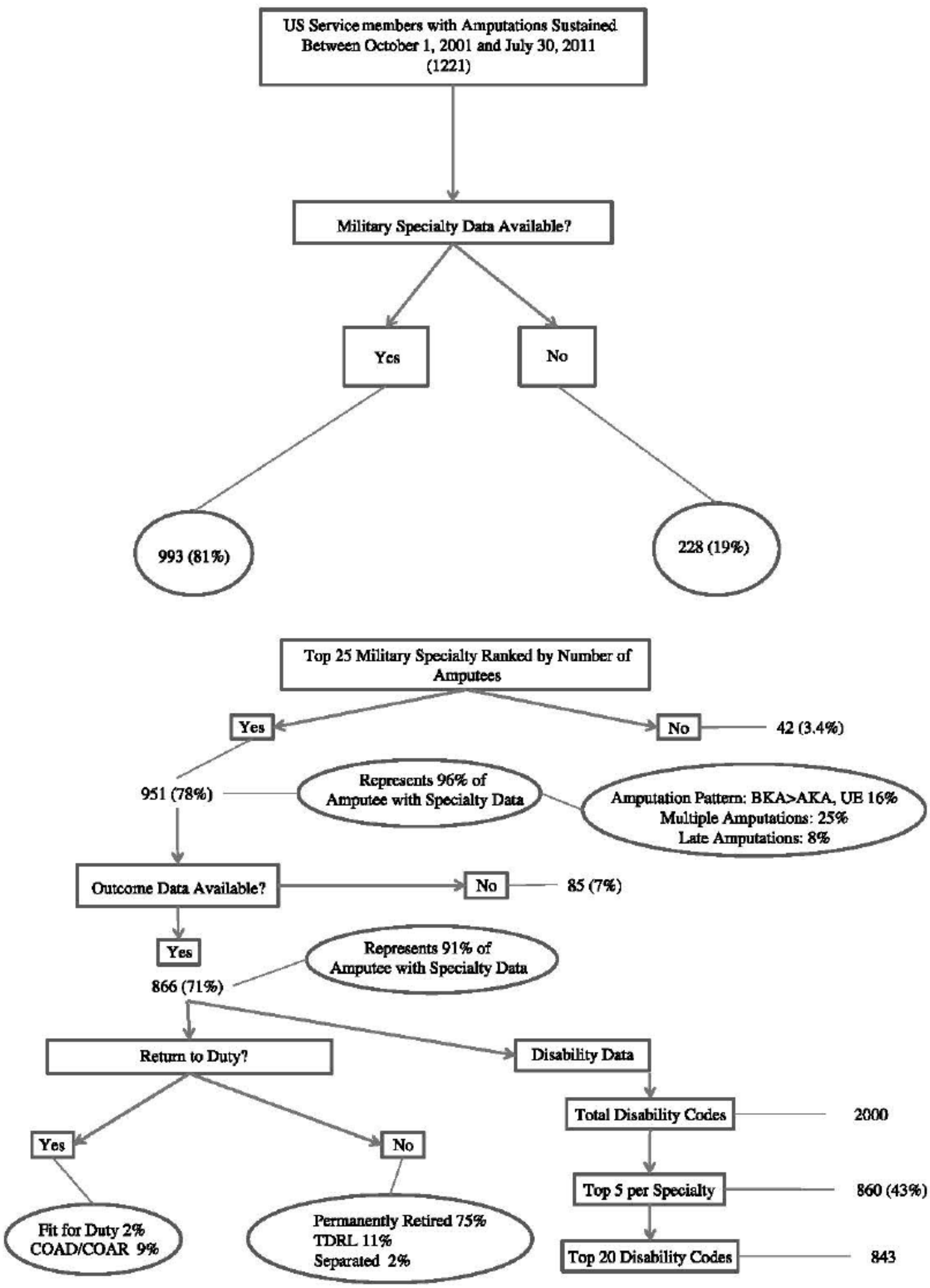

Figure 1. Visual representation demonstrating path to determine amputee characteristics and outcome.

and July 30, 2011, in Iraq and Afghanistan.[4] Cohort data were derived from multiple sources including the Military Amputation Database (Fort Sam Houston, Texas), the Joint Theater Trauma Registry (Fort Sam Houston, Texas), the Defense Manpower Data Center, and the Office of the Surgeon General. The following information was assembled on each amputee from those registries: demographic information, military specialty, Injury Severity Score (ISS) and pattern of amputation.[4] ISS is based on a scale from 0 to 75; Abbreviated Injury Scale (AIS) individual scores of 6 will equal an ISS score of 75 (fatal), and a score greater than 15 is typically considered serious or defined as moderate polytrauma.[9] Amputation patterns were classified as the following: below-the-knee amputation (BKA), through-the-knee amputation (TKA), above-the-knee amputation (AKA), lower-extremity (LE) other (ankle disarticulation, hip disarticulation, hemipelvectomy), and upper-extremity (UE) amputation (all UE amputation subtypes ranging from wrist disarticulation to shoulder disarticulation). An amputee was considered a multiple amputee if he had more than one major extremity amputation performed; an amputation was characterized as late if it was performed greater than 90 days from injury.[10] Personnel were from the US Army (USA), the US Air Force (USAF), the US Marine Corps (USMC), and the US Navy.

Information specific to return to duty and long-term disability was obtained from the Physical Evaluation Board Liaison Office for each branch of service. The following information was obtained: final disposition of duty, combined disability rating, and the disabling conditions contributing to an amputee's combined disability rating. Each service's physical evaluation board uses information regarding a service member's injuries and disabling conditions to determine if a service member is able to continue with military service and, if so, in what capacity. In addition, these evaluation boards are in charge of determining what type of disability-related composition to which each service member is entitled.[11–14]

Personnel without military occupational specialty data were excluded (Fig. 1). Data were assembled as a function of MOS by using occupational codes particular to each branch of service. A ranked list of the top 25 MOS based on the number of amputees per specialty was created, and amputation patterns relative to each specific military specialty were identified (Fig. 1).

Disposition and disability data for each specialty were analyzed. Service members without this information were excluded (Fig. 1). Amputees are classified as either fit for duty, continuation on active duty/reserve in a limited capacity (COAD/COAR), placed on a temporary disabled retirement list (TDRL), separated from service with severance pay and no long-term benefits, or permanently medically retired. Amputees placed on a TDRL are granted the same privileges as permanently retired personnel, but their cases are periodically reviewed, and the member is permanently retired if his condition is not improving.[11–13] Service members were considered retained if classified as fit for duty or COAD/COAR (Fig. 1). In addition, a combined disability rating was determined based on the member's disability codes. Marine, Navy, and Air Force amputees are evaluated using similar criteria and were categorized according to the Army data that matched their final disposition.

Disability was further analyzed using the disability codes of the amputees for each MOS. A service member's disability rating is often a combination of different disability codes (i.e., different causes for long-term disability). For example, a member may have a disability rating of 60, which is composed of a disability code for an LE amputation and a code for traumatic arthritis of a joint. Thus, disability ratings are a function of both the number of different codes and the total number of codes. For this study, the top five codes from each specialty were determined based on the number of amputees with that documented code (Fig. 1). The top five codes were then analyzed to determine which codes occurred most often among all specialties (Fig. 1).[14]

Statistical analyses were performed to assess for differences across specialties. Dichotomous variables were compared using the χ^2 test or Fisher's exact test, as appropriate. All reported p values are two-tailed, with $p \leq 0.05$ representing statistical significance.

RESULTS

Demographics

Previously published data involving the aforementioned databases contained information on 1,221 amputees (1,631 amputations) and were combined and correlated with the amputee's disposition and disability information.[4] Complete MOS data were available for 993 service members (81.3%). The top 25 military specialties relative to amputees included 951 service members (96% of amputees with specialty data). Complete outcome data were available for 899 amputees; the top 25 military specialties represented 866 amputees (91% of amputees with specialty data) (Fig. 1). Amputations occurred most common in enlisted males in infantry units with an average age of 25 years (Table 1).

The top 25 specialties involved 96% of the amputees. Personnel from the USA Infantry, USMC Infantry, and USA Armor represented the top three specialties with 312 (31.4%), 176 (17.7%), and 84 (8.5%) amputees, respectively (Table 2). Members of the infantry were significantly more likely to have amputations compared with members of all other military specialties ($p < 0.0001$), and USA Infantry soldiers were significantly more likely than USMC infantry marines to sustain amputations ($p < .0001$). Infantry (both USMC and USA), engineers (both USMC and USA), and USA Armor

TABLE 1. Cohort Demographics for US Service Members With Amputations and Complete Military Specialty Data Between October 1, 2001, and July 30, 2011

Branch of Service	Mean Age, y	Male, %	Median Rank	Enlisted, %	Mean ISS	Amputees		Amputations	
						n	%	n	%
Army	25	97	E4	92	20	721	73	896	56
Marine	25	100	E4	96	21	255	26	366	20
Air Force	25	100	E5	100	21	15	2	19	1
Navy	23	100	E4	100	21	2	0	2	0
Total	25	98	E4	93	21	993		1,283	

TABLE 2. Top 25 Military Specialties and Amputation Patterns

			Amputee		Amputation		ISS		BKA		TKA		AKA		LE Other*		Total UE**		Multiple		Late†	
No.	**Branch**	**Specialty**	**n**	**%‡**	**n**	**%§**	**Mean**	**Median**	**n**	**%¶**	**n**	**%¶**	**n**	**%¶**	**n**	**%¶**	**n**	**%¶**	**n**	**%||**	**n**	**%††**
1	USA	Infantry	312	31	392	31	21	18	177	45	23	6	114	29	17	4	61	16	76	24	33	11
2	USMC	Infantry	176	18	247	19	21	18	102	41	14	6	94	38	6	2	31	13	61	35	22	13
3	USA	Armor	84	8	109	8	21	18	53	49	3	3	28	26	5	5	20	18	24	29	14	17
4	USA	Engineer	66	7	84	7	20	18	36	43	4	5	30	36	2	2	12	14	17	26	4	6
5	USA	Artillery	55	6	69	5	20	18	31	45	1	1	20	29	4	6	13	19	14	25	5	9
6	USA	Military police	49	5	59	5	20	18	24	41	1	2	24	41	0	0	10	17	0	0	2	4
7	USMC	Engineer	26	3	41	3	22	20	15	37	4	10	20	49	0	0	2	5	14	54	3	12
8	USA	MTO	24	2	28	2	20	17	13	46	2	7	5	18	3	11	5	18	0	0	2	8
9	USA	Special Forces	19	2	22	2	20	17	10	45	0	0	6	27	0	0	6	27	3	16	0	0
10	USA	MM	19	2	24	2	20	17	9	38	1	4	7	29	2	8	5	21	2	11	4	21
11	USA	Logistics	16	2	21	2	20	17	11	52	0	0	5	24	2	10	3	14	5	31	2	13
12	USA	Ordnance	11	1	13	1	20	17	5	38	0	0	5	38	1	8	2	15	2	18	0	0
13	USA	Sign corps	10	1	11	1	20	18	6	55	0	0	3	27	2	18	0	0	1	10	2	20
14	USA	EOD	9	1	11	1	20	18	4	36	2	18	0	0	0	0	5	45	2	22	2	22
15	USMC	Motor transport	9	1	11	1	21	18	5	45	1	9	2	18	1	9	2	18	2	22	1	11
16	USA	Air defense	8	1	10	1	20	18	5	50	0	0	2	20	0	0	3	30	2	25	1	13
17	USAF	EOD	8	1	8	1	22	19	5	63	0	0	1	13	0	0	2	25	0	0	2	25
18	USMC	Artillery	8	1	12	1	21	19	2	17	1	8	5	42	1	8	3	25	2	25	0	0
19	USA	Civil affairs	7	1	7	1	20	18	3	43	0	0	1	14	0	0	3	43	0	0	0	0
20	USA	Combat medic	7	1	7	1	20	18	4	57	0	0	3	43	0	0	0	0	1	14	1	14
21	USMC	EOD	7	1	13	1	21	18	1	8	2	15	8	62	0	0	2	15	6	86	1	14
22	USA	Human resources	6	1	6	0	20	18	3	50	0	0	1	17	1	17	1	17	0	0	0	0
23	USA	Aviation	5	1	7	1	20	18	2	29	0	0	3	43	0	0	2	29	2	40	0	0
24	USA	Intelligence	5	1	7	1	20	18	4	57	1	14	2	29	0	0	0	0	2	40	2	40
25	USMC	Communication	5	1	12	1	21	18	4	33	1	8	3	25	4	33	0	0	3	60	0	0
Totals			951	96	1231	96	21	18	534	43	61	5	392	32	51	4	193	16	241	25	103	8
Overall amputations			993		1,284				556	43	63	5	412	32	52	4	201	16	250	25	111	9

*Lower extremity other involved amputation levels other that BKA, TKA, and AKA
**Total UE amputations involving all levels.
†Amputations performed after 90 days.
‡Percentage of amputee per total amputees with specialty data available (993).
§Percentage of amputations per total amputations (1,284).
¶Percentage of specific amputation per total amputations per specialty.
||Percentage of amputees with multiple amputations per total amputees in each specialty.
††Percentage of amputees from specific specialty who underwent late amputation (>90 days from injury).
MM, mechanical maintenance; MTO, motor transport operator.

personnel represented 67.4% of all amputees (Table 2). Of note, the mean and median ISS for the top 25 specialties was 21 and 18, respectively, and had little variation between MOS (Table 2).

Most common amputation patterns are as follows: 534 BKAs (43%), 392 AKAs (32%), and 61 TKAs (5%). There were 193 UE amputations (16%); 25% of amputees had multiple amputations, and 8% of all personnel underwent a late amputation (Table 2). The amputation rates did not vary among the top 25 MOS specialties.

Within the top three MOS, BKA was the most common LE amputation, followed by AKA, and the UE amputation rate per the total number amputations within a specialty was between 12.6% and 18.3%. Between 24.4% and 34.7% of amputees sustained multiple amputations, and between 10.6% and 16.7% underwent late amputations. The USMC engineers (48.8%), USAF (41.7%) and USMC (61.5%) explosive ordinance disposal (EOD) personnel, and USA Aviation personnel (42.9%) sustained more AKAs than BKAs (Table 2).

Disposition and Disability

The majority of amputees from the top 25 specialties did not return to active duty (Table 3). In fact, only 14 service members (2%) were classified as fit for duty and, thus, returned to their preinjury MOS. The mean and median combined disability for the top 25 MOS was 76 and 80, respectively, and did not vary substantially between specialties (Table 3). The return-to-duty rate for the top three specialties ranged from 0 of 176 amputees (USMC Infantry) to 44 or 312 amputees (USA Infantry) (Table 3).

TABLE 3. Military Specialty and Return to Duty

			Amputee	Outcome Data		COAD/ COAR		Fit for Duty		Permanently Retired		TDRL		Separated		Combined Disability	
No.	Branch	Specialty	n	n	%*	n	%**	n	%**	n	%**	n	%**	n	%**	Mean	Median
1	USA	Infantry	312	303	97	38	13	6	2	226	75	33	11	0	0	76	80
2	USMC	Infantry	176	130	74	0	0	0	0	93	72	16	12	12	9	75	80
3	USA	Armor	84	79	94	5	6	1	1	65	82	8	10	0	0	76	80
4	USA	Engineer	66	65	98	6	9	1	2	45	69	13	20	0	0	77	80
5	USA	Artillery	55	50	91	2	4	0	0	42	84	6	12	0	0	77	80
6	USA	Military police	49	48	98	6	13	1	2	38	79	3	6	0	0	77	80
7	USMC	Engineer	26	17	65	0	0	0	0	12	71	2	12	3	18	76	80
8	USA	MTO	24	24	100	1	4	0	0	20	83	3	13	0	0	76	80
9	USA	Special forces	19	19	100	7	37	4	21	6	32	2	11	0	0	77	80
10	USA	MM	19	16	84	0	0	0	0	16	100	0	0	0	0	77	80
11	USA	Logistics	16	16	100	1	6	0	0	14	88	1	6	0	0	77	80
12	USA	Ordnance	11	11	100	1	9	0	0	7	64	3	27	0	0	77	80
13	USA	Sign corps	10	10	100	0	0	0	0	6	60	4	40	0	0	77	80
14	USA	EOD	9	9	100	1	11	0	0	8	89	0	0	0	0	77	80
15	USMC	Motor transport	9	7	78	0	0	0	0	7	100	0	0	0	0	77	80
16	USA	Air defense	8	8	100	1	13	0	0	7	88	0	0	0	0	77	80
17	USAF	EOD	8	7	88	0	0	1	14	6	86	0	0	0	0	N/A	N/A
18	USMC	Artillery	8	7	88	0	0	0	0	4	57	0	0	3	43	75	80
19	USA	Civil affairs	7	7	100	1	14	0	0	6	86	0	0	0	0	77	80
20	USA	Combat medic	7	6	86	0	0	0	0	5	83	1	17	0	0	81	90
21	USMC	EOD	7	7	100	0	0	0	0	4	57	0	0	3	43	75	80
22	USA	Human resources	6	6	100	3	50	0	0	1	17	2	33	0	0	77	80
23	USA	Aviation	5	5	100	1	20	0	0	3	60	1	20	0	0	76	80
24	USA	Intelligence	5	5	100	0	0	0	0	4	80	1	20	0	0	75	80
25	USMC	Communication	5	4	80	0	0	0	0	4	100	0	0	0	0	80	90
	Total		951	866	91	74	9	14	2	649	75	99	11	21	2		

*Percentage of amputees per specialty.
**Percentage of amputees per available outcome data.
MM, mechanical maintenance; MTO, motor transport operator.

Members of the USA Special Forces (USA SF) had the highest return-to-duty rate, with 58% of amputees retained (37% classified as COAD/COAR and 21% as fit for duty) (Table 3). USA SF service members were significantly more likely to be retained via COAD/COAR (p = 0.0022) or fit for duty (p = 0.0015) compared with all other USA specialties (including infantry) and significantly less likely to be permanently retired compared with all other USA specialties (p = 0.0001). The USMC had 21 amputees (4% of USMC amputees with both MOS and outcome data available) who were separated with severance and no benefits.

Disability for the top three specialties was similar to the entire cohort; musculoskeletal and neurologic related disability contributed to disability in 93% of the amputees (Table 4). The musculoskeletal disability codes represented for the top three specialties were all amputation related (Table 4). post-traumatic stress disorder (PTSD) was the third most common disability code for USA Infantry and USA Armor and the fourth for USMC Infantry; it contributed to the long-term disability for 79 of 382 amputees or 21% of the amputees within those specialties (Table 4). Additional analysis of all codes documented for the top 25 specialties indicated that 136 amputees (16%) had a code or combination of codes involving PTSD. This was followed by 93 amputees (11%) with a code or combination of codes for traumatic brain injury (TBI). Lastly, members of the USA SF did not have any codes representing PTSD among either the top five disability codes (Table 5) or upon further analysis of all codes assigned to members of the USA SF.

DISCUSSION

This study illustrates some important points relative to military specialties, amputation patterns, and final disposition during recent combat. First, the majority of amputees are from a small number of military specialties (infantry, USA Armor, and engineering). While it may be intuitive that some occupations are more dangerous than others, this study provides data to support this idea. Second, the overall pattern of amputations (i.e., BKA vs. AKA vs. UE amputations) was relatively similar among the specialties and consistent with previous studies.[3,4] Similar amputation patterns among specialties may be caused by the fact that the majority of amputations and/or extremity injuries were

TABLE 4. Military Specialty and Top Five Disability Codes

No.	Branch	Specialty	Outcome n	1. Code No.	n	%*	2. Code No.	n	%*	3. Code No.	n	%*	4. Code No.	n	%*	5. Code No.	n	%*	Total Top Codes	Total Codes
1	USA	Infantry	303	5165	112	37	5107	52	17	9411	49	16	5162	40	13	7801	19	6	272	676
2	USMC	Infantry	130	5165	60	46	5107	38	29	5162	25	19	9411	21	16	8045	14	11	158	359
3	USA	Armor	79	5165	26	33	5107	15	19	9411	14	18	5162	11	14	7800	8	10	74	197
4	USA	Engineer	65	5165	21	32	5107	12	18	5162	12	18	9411	6	9	5123	3	5	54	126
5	USA	Artillery	50	5165	15	30	5107	9	18	5162	8	16	9411	8	16	5122	5	10	45	107
6	USA	Military police	48	5165	14	29	5162	12	25	5107	6	13	9411	5	10	5122	3	6	40	102
7	USMC	Engineer	17	5107	11	65	5165	7	41	9411	3	18	5162	2	12	5110	2	12	25	44
8	USA	MTO	24	5165	9	38	7801	6	25	5107	5	21	9411	3	13	5124	2	8	25	54
9	USA	Special forces	19	5165	6	32	5124	3	16	5110	2	11	5125	2	11	8514	2	11	15	30
10	USA	MM	16	5162	5	31	5165	5	31	5107	3	19	5271	3	19	8045/9304	3	19	19	47
11	USA	Logistics	16	5162	4	25	5107	3	19	5165	3	19	9411	3	19	5110	2	13	15	30
12	USA	Ordnance	11	5162	4	36	5107	2	18	5165	2	18	5122	1	9	5124	1	9	10	20
13	USA	Sign corps	10	5165	5	50	5162	2	20	7804	2	20	9411	2	20	5010	1	10	12	26
14	USA	EOD	9	5165	4	44	5124	2	22	5106	1	11	5107	1	11	5123	1	11	9	22
15	USMC	Motor Transport	7	5165	4	57	9411	2	29	8045	2	29	5164	2	29	9304	1	14	11	20
16	USA	Air defense	8	5165	2	25	5107	1	13	5120	1	13	5123	1	13	5124	1	13	6	14
17	USAF	EOD	7	5165	5	71	8045	3	43	9411	2	29	5321–5399	1	14	5271–5003	1	14	12	22
18	USMC	Artillery	7	5165	2	29	8511	1	14	5228	1	14	5162	1	14	5125	1	14	6	8
19	USA	Civil affairs	7	5165	3	43	5122	1	14	5123	1	14	5124	1	14	5161	1	14	7	14
20	USA	Combat medic	6	5165	4	67	5124	2	33	5107	1	17	5140	1	17	5161	1	17	9	20
21	USMC	EOD	7	5107	2	29	9304	1	14	8616	1	14	8612	1	14	8515	1	14	6	16
22	USA	Human resources	6	5165	3	50	5123	1	17	5162	1	17	5166	1	17	5171	1	17	7	17
23	USA	Aviation	5	5162	2	40	5165	2	40	8513	2	40	5106	1	20	5161	1	20	8	9
24	USA	Intelligence	5	5107	2	40	5165	2	40	5162	1	20	5271	1	20	8520	1	20	7	8
25	USMC	Communication	4	9411	2	50	8045	2	50	5107	2	50	7121/7199	1	25	8615	1	25	8	12
	Total		866		327			186			150			120			77		860	2,000

*Percentage of amputees per available outcome data.
MM, mechanical maintenance; MTO, motor transport operator.

TABLE 5. Disability Codes Representation for Top 25 Specialties and Definitions

Code No.	Total Top 5 Codes n	Category %	Definition	
5165	316	37	Musculoskeletal	Leg amputation
5107	165	19	Musculoskeletal	Anatomical loss of both feet.
5162	130	15	Musculoskeletal	Thigh amputation
9411	120	14	Neurologic	Posttraumatic stress disorder.
7801	25	3	Skin	Burn scar(s) or scar(s) caused by other causes, not of the head
8045	21	2	Neurologic	TBI
5124	12	1	Musculoskeletal	Forearm amputation
5122	10	1	Musculoskeletal	Arm amputation
7800	8	1	Skin	Burn scar(s) of the head
5123	7	1	Musculoskeletal	Forearm amputation
5110	6	1	Musculoskeletal	Loss of use of both feet.
5271	4	0	Musculoskeletal	Ankle, limited motion
5125	3	0	Musculoskeletal	Forearm amputation
5161	3	0	Musculoskeletal	Thigh amputation
8045/9304	3	0	Neurologic	TBI/dementia caused by head trauma
5106	2	0	Musculoskeletal	Anatomic loss of both hands.
5164	2	0	Musculoskeletal	Leg amputation
7804	2	0	Skin	Scar(s), unstable or painful.
8513	2	0	Neurologic	All radicular groups, paralysis.
8514	2	0	Neurologic	All radicular groups, paralysis.

the result of explosive devices.[1–4] Third, the overall rate of late amputations in this study (8%) and among specialties was similar to previous data (15.2%) and consistent across the top three specialties with rates between 10.6% and 16.7%.[10] Lastly, the severity of the amputees' injuries measured by the ISS was comparable among specialties. This demonstrates that most amputees, regardless of specialty, have similar injuries and amputation patterns despite having very different occupations and roles within the military.

Although the injuries and amputation patterns were similar for all MOS, such was not the case when looking at the final disposition status of all MOS. The overall return-to-duty rate for this study was similar to previous data but differed for members of the USA SF. Stinner et al.[15] documented a 16.5% return-to-duty rate for their cohort; the return-to-duty rate for the top 25 specialties in this study was 11%. In general, amputees or injuries involving amputations tend to result in the amputee not being retained for military service. However, this study shows that members of the USA SF have a significantly higher chance of returning to duty and not being permanently retired. Although USA SF soldiers had similar amputation patterns and ISSs relative to other specialties, they were being retained and found fit for duty at much higher rates compared with all other MOS. These higher rates may indicate a difference in motivation, resources, or opportunities for USA SF personnel to return to duty relative to other military occupations.

This study also demonstrates that combined disability ratings and disability code representation between specialties and the top three specialties were comparable. The results of this study show musculoskeletal disability, encompassing amputation-related and extremity-related disability, is the main cause of long-term disability involving military amputees. This was demonstrated in previous studies; Cross et al.[16] noted, "Of all unfitting conditions, 70% were orthopaedic." Nonmusculoskeletal disability also contributed to military amputees' overall disability, namely PTSD. It affected almost one of five amputees in the top three specialties and 16% of the entire cohort. Cross et al.[16] documented that PTSD was the number five "unfitting condition by impact" involved with long-term disability of injured military personnel. This ranked above UE amputation in their study—likely because the number of service members with UE amputations is low compared with those affected by PTSD. Interestingly, none of the members of USA SF had a documented PTSD disability code, and this may have contributed to their increased rate of being found fit for duty or retained on active duty. Through personal communication, one of the authors (C.A.K.) has learned that USA SF personnel are not allowed to return to their unit's team if they are diagnosed with PTSD. This stipulation may influence the diagnosis PTSD among USA SF personnel.

There are a number of strengths relative to this study. First, this study correlates a large cohort of amputees with comprehensive outcome data. Second, the amputees in this study have been followed up in a longitudinal manner (i.e., from injury to disposition relative to military service). This has made it possible to highlight patterns from initial injury to the conclusion of the service member military service or return to service.

There are also limitations to this study. First, this is a retrospective review of records and is susceptible to the pitfalls of such studies. For example, owing to the size of the cohort, the dynamic nature of war, and the multiple agencies involved, errors in documentation are likely to have occurred. As a result, this study did not account for every amputation preformed during the noted time frame. Furthermore, it did not account for complete specialty, disposition, and disability data for all amputees or all service members who sustained amputations during the time frame analyzed in this study; complete data were only available for 899 amputees or 73.6%. For example, detailed information and/or data were unavailable for most of the Navy sailors who sustained amputations. Second, the external validity of this study is limited. The mechanism of injury leading to amputations and the support network for military members differs from civilian trauma patients.[3–8] For instance, amputations from the last 10 years were the result of explosive injuries, while the majority of civilian trauma-related amputations are vehicular related.[1–8] Furthermore, almost all military members have access to comprehensive health care, while Bosse et al.[6] documented that 38% of the civilian trauma amputees in their study either did not have insurance or had public insurance. Lastly, this study did not account for a number of preinjury variables such as preinjury fitness level, body mass index, service component (reserve vs. active duty), and so on. It is likely that these variable could have had an impact of the amputees' outcome.

Amputation and extremity injuries have a psychological, physical, and financial impact on society and the military. Masini et al.[17] analyzed 1,333 military personnel with combat-related wounds and asserted that 64% of the $170 million of total projected disability cost would be extremity related. Furthermore, MacKenzie et al.[5] estimated the lifetime cost per amputee to be greater than $500,000. Therefore, the cost of caring for the 993 amputees analyzed in this study could be more than $496 million. Therefore, preventing such injuries is a cost-effective strategy with the most efficient use of resources directed at preventing injuries in specialties, which are more susceptible to amputations.

CONCLUSION

Amputation rates occurred most commonly among USA and USMC Infantry and combat engineer specialties, with a return-to-duty rate of 8.8%. The exception to this finding is a fit-for-duty rate of 21% and retention in military service of 58% among members of USA SF commando units. This discrepancy needs further clarification to identify possible factors that contribute to higher occupational success following combat-related amputation.

AUTHORSHIP

The following are the contributions each author had for this article. J.G.B. contributed efforts in the study design, literature search, data collection, data analysis/interpretation, figure composition, table composition, writing, and revisions. C.A.K. contributed efforts in the study design, literature search, data collection, data analysis/interpretation, figure composition, table composition, writing, and revisions. J.C.W. was an integral part of the study idea, study design, reference literature, data analysis/interpretation, figure and table composition, and critical revisions and editing of the article.

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DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Owens BD, Kragh JF Jr, Macaitis J, Svoboda SJ, Wenke JC. Characterization of extremity wounds in Operation Iraqi Freedom and Operation Enduring Freedom. *J Orthpaedic Trauma*. 2007;21:254 257.
2. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in Operation Iraqi Freedom and Operation Enduring Freedom. *J Trauma*. 2008;64:295 299.
3. Stansbury LG, Lalliss SJ, Branstetter JG, Bagg MR, Holcomb JB. Amputations in US military personnel in the current conflicts in Afghanistan and Iraq. *J Orthop Trauma*. 2008;22:43 46
4. Krueger CA, Wenke JC, Ficke JR. Ten years at war: comprehensive analysis of amputation trends. *J Trauma Acute Care Surg*. 2012;73: S438 S444.
5. MacKenzie EJ, Jones AS, Bosse MJ, et al. Health-care costs associated with amputation or reconstruction of a limb-threatening injury. *J Bone Joint Surg Am*. 2007;89:1685 1692.
6. Bosse MJ, MacKenzie EJ, Kellam JF, et al. An analysis of outcomes of reconstruction or amputation after leg-threatening injuries. *N Engl J Med*. 2002;347(24):1924 1931.
7. Mackenzie EJ, Bosse MJ, Castillo RC, Smith DG, Webb LX, Kellam JF, Burgess AR, Swiontkowski MF, Sanders RW, Jones AL, et al. Functional outcomes following trauma-related lower-extremity amputation. *J Bone Joint Surg Am*. 2004;86:1636 1645.
8. MacKenzie EJ, Bosse MJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson TM et al., Characterization of patients undergoing amputation versus limb salvage for severe lower extremity trauma. *J Orthop Trauma*. 2000;14:455 466.
9. Dougherty AL, Mohrle CR, Galarneau MR, Woodruff SI, Dye JL, Quinn KH. Battlefield extremity injuries in Operation Iraqi Freedom. *Injury*. 2009;40:772 777.
10. Stinner DJ, Burns TC, Kirk KL, Scoville CR, Ficke JR, Hsu JR; Late Amputation Study Team. Prevalence of late amputations during the current conflicts in Afghanistan and Iraq. *Mil Med*. 2010;175:1027 1029.
11. Personnel Separations: Physical Evaluation for Retention, Retirement, or Separation. Army Regulations 635-40. Updated February 8, 2006. Available at: http://armypubs.army.mil/epubs/pdf/r635 40.pdf. Accessed November 28, 2012.
12. Medical Services: Standards of medical fitness. Army Regulations 40-501. Updated December 14, 2007. Available at: http://www.army.mil/usapa/epubs/pdf/r40 501.pdf. Accessed November 28, 2012.
13. Medical Services: Patient administration. Army Regulations 2008. Available at: http://armypubs.army.mil/epubs/pdf/r40 400.pdf. Accessed November 28, 2012.
14. Veterans Benefits Administration References: Book C, schedule for rating disabilities. Title 38 Code of Federal Regulations. Available at: http://www.benefits.va.gov/warms/bookc.asp. Accessed November 28, 2012.
15. Stinner DJ, Burns TC, Kirk KL, Ficke JR. Return to duty rate of amputee soldiers in the current conflicts in Afghanistan and Iraq. *J Trauma*. 2010;68:1476 1479.
16. Cross JD, Ficke JR, Hsu JR, Masini BD, Wenke JC. Battlefield orthopaedic injuries cause the majority of long-term disabilities. *J Am Acad Orthop Surg*. 2011;19(Suppl 1):S1 S7.
17. Masini BD, Waterman SM, Wenke JC, Owens BD, Hsu JR, Ficke JR. Resource utilization and disability outcome assessment of combat casualties from Operation Iraqi Freedom and Operation Enduring Freedom. *J Orthop Trauma*. 2009;23(4):261 266.